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THEORETICAL INVESTIGATION OF ATOMIC STRUCTURE AND SCATTERING PR--ETC(U)

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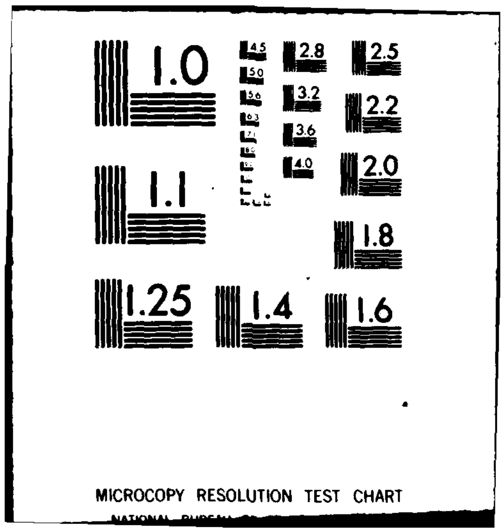
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One area explored is the use of intense laser beams in interaction with atomic systems; the interaction of the projectile and target in a scattering problem with the laser beam is accounted for. We have further explored the applicability of variational methods in general scattering processes.

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Summary

1. Principal Investigators: Larry Spruch and Leonard Rosenberg (New York University, Department of Physics, contract number N00014-76-C-0317).

2. Contract Description. We will continue to study electron-atom scattering processes in the presence of a laser field, for this can help to provide a better understanding of the interaction of a laser beam and matter. We will continue our attempts to develop and improve methods for the reliable evaluation of scattering parameters and bound state properties. We will attempt to utilize recent developments in Thomas-Fermi theory.

3. Scientific Problem.

The use of intense laser beams in interaction with atomic systems motivates the development of a relatively new area of scattering theory, in which the interaction of the projectile and target with the laser beam is accounted for. Calculational methods must be developed to the point where reliable predictions can be made.

It is almost always impossible to calculate the rates of atomic scattering processes exactly. It is therefore important to have available accurate approximation methods. We have attempted to develop calculational procedures which are simpler, more reliable and more effective than those presently available, and we shall continue to do so. In particular, while variational methods have been used for some time this approach has still not been thoroughly explored and we shall attempt to both improve the efficiency of the variational approach for a given problem and to widen the class of problems to which it can be applied.

4. Scientific and Technical Approach.

The theory of scattering in a laser field is being developed in close parallel to standard time-independent scattering theory, in which a quantum, rather than classical, description of the field is used. Gauge transformations and modified perturbation expansions are used in the analysis.

We shall be concerned with variational methods of calculation; the merit of a variational calculation is that it enables one to arrive at a level of accuracy in the final result which greatly exceeds the accuracy of the trial function used as input to the calculation.

5. Progress.

We have been examining the problem of electron-atom scattering in a low frequency radiation field, either externally imposed or spontaneously produced. Progress has been made in taking into account the interaction of the atomic target, as well as the incoming electron, with the field. This interaction will be particularly significant when the target energy levels are closely spaced. In the area of charge transfer, we used a relatively simple (physical) derivation of the double scattering contribution to the cross section at asymptotically high impact velocities to estimate the cross section for a rather similar process, H-atom capture from CH_4. While the asymptotic domain is not reached for the usual charge transfer process, with an electron transferred, until the incident atom has an energy of many millions of electron volts, that domain is reached in atom-capture at only about 100

electron volts. The predictions of the theory are in much better agreement with the data than those of the semi-classical theory. In quantum electrodynamics, dealing with effects of vacuum fluctuations on long-range atomic interactions, we have calculated the radiative corrections to the energy levels of an electron bound to a wall. For an ideal wall the effects are some 10,000 times the radiative correction for the Lamb shift in a hydrogen atom; unfortunately, the effects for a real wall are comparable to the radiative correction for the Lamb shift in a hydrogen atom. We have also studied the generalized oscillator strength and have set up a simple approximation method valid for large values of the momentum transfer, and applied it to the helium atom.

6. Publications.

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R. Shakeshaft, Comment on the inelastic scattering of relativistic charged particles. Submitted to Phys. Rev. A.

7. <u>Extenuating Circumstances</u>.

None.

8. We do not expect to have any unspent funds remaining at the end of the contract period.

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10. National Science Foundation.

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